(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 420 231 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
08.07.2020 Bulletin 2020/28

(21) Application number: **17708980.2**

(22) Date of filing: **14.02.2017**

(51) Int Cl.:
F04B 15/08 *(2006.01)*

(86) International application number:
PCT/EP2017/053199

(87) International publication number:
WO 2017/144299 (31.08.2017 Gazette 2017/35)

(54) **DEVICE AND CORRESPONDING METHOD FOR THE DISPENSING OF LIQUID CO2 IN ENVIRONMENTS WITH PRESSURE LOWER THAN THAT OF ITS TRIPLE POINT**

VORRICHTUNG UND VERFAHREN ZUR FÖRDERUNG VON FLÜSSIGEM CO2 IN EINER UMGEBUNG IN DER EIN DRUCK UNTERHALB DES TRIPELPUNKT DRUCKES HERRSCHT

DISPOSITIF ET PROCÉDÉ POUR POMPER DU CO2 DANS SON ÉTAT LIQUIDE DNAS UN ENVIRONNEMENT AYANT UNE PRESSION EN DESSOUS DE LA PRESSION AU POINT TRIPLE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **23.02.2016 IT UB20160983**

(43) Date of publication of application:
02.01.2019 Bulletin 2019/01

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Printed by Jouve, 75001 PARIS (FR)

Description

Field of the invention

[0001] The present invention relates to a method and a device for regulating in a continuous and accurate manner a flow of liquid CO2 towards apparatuses wherein the pressure is lower than that of its triple point, that is in environments wherein the CO2 can exist only in the solid state, commonly known also as carbonic snow, and aeriform state but not in the liquid one.

[0002] The thermodynamic features of the CO2 indicate that the latter in the liquid state, and therefore at a pressure higher than that of the triple point, if left to expand to pressures below those which correspond to this point, part will be transformed into carbonic snow and part aeriform, in proportions which depend on the values of T and P both in the original state and in the arrival environment.

[0003] As is known, the triple point of CO2 is characterised by having, as thermodynamic coordinates, the pressure of approximately 5.1 Ata (absolute atmospheres) and the temperature of approximately -56.6°C.

[0004] The pressure at which the CO2 is at in the stores normally used is around 20 atmospheres, which corresponds to a temperature of approximately -20°C, if the store is a tank of the cryogenic type in which it is contained in the liquid state while boiling. Between 40 and 70 atmospheres if it is stored in cylinders in which it is again contained in the liquid state while boiling but at ambient temperature.

[0005] When the use of carbonic snow is required, its formation and the transfer of the latter and of the aeriform associated therewith in and via pipes or conduits entails the high probability of having clogging of the same - a probability which increases as their length increases, with the presence of curves, narrowings, etc. - so that in order to avoid this it is necessary to operate with special techniques and methods which affect its management and limit the possibilities of use, as will be described here below.

[0006] There are multiple applications of CO2 which take place at pressures lower than that of the triple point and which make use both of its refrigerating properties due to the capacity of subtracting heat following sublimation of the snow and the thermal capacity of the aeriform phase due to its chemical and physical properties such as, by way of an example, the solubility and the consequent formation of carbonic acid and/or carbonates in aqueous solutions.

[0007] In these latter cases where the refrigerating capacities are not required, the CO2 is used via dispensing in aeriform phase after vaporisation of the liquid, usually performed with systems which use electrical energy as heat source, and this even if the environment or the apparatus in which it is required has available the heat necessary for its vaporisation, i.e. it can receive the snow to which it supplies heat, transforming it into vapour.

[0008] The reason for the supply in aeriform phase in the cases above lies in the fact that where accuracy is required on the values of the flow rate of the CO2 it is preferable to measure it and dispense it in aeriform phase rather than in the liquid one.

[0009] Some examples by way of illustration of this type of uses are carbonation, or gassing, of mineral waters and of drinks and the neutralisation of alkaline aqueous solutions.

Background of the invention and prior art

[0010] Currently the dispensing of liquid CO2 and the consequent formation of aeriform and carbonic snow in the environment of use operating at a pressure lower than that of the triple point is performed mainly with 3 methods.

[0011] The first operates via conduits for feeding liquid CO2 provided with valves with functioning of the ON/OFF type where the quantity dispensed in ON phase is constant and defined by the dimensions of the orifices or holes placed at the end of the conduits connected to the use apparatus.

[0012] By appropriately dimensioning these conduits, with valve at ON, a pressure is obtained which is approximately equal to that of the store, or in any case at values higher than that of the triple point, and the CO2 contained remains in liquid phase.

[0013] The formation of snow and aeriform takes place only downstream of the calibrated hole, that is in the use apparatus.

[0014] The limits presented by this method are mainly two:

- The dispensing is of the ON-OFF type where the flow rate is constant during the ON phase so that the overall regulation of the quantity to be fed can be done only by regulating the ON time and not the flow rate.
- The difficulty in having low and well-defined flow rates due to the high jump in pressure between the existing one in the conduit upstream of the calibrated hole and the one in the use apparatus, difficulty consequent to the need to have calibrated holes with passage areas with very limited dimensions.

[0015] By way of an example it should be considered that at the average working pressures of cryogenic stores (18-20 bar) during the dispensing of liquid CO2 in an apparatus operating at atmospheric pressure, the variation of 1 mm^2 of section of the calibrated hole entails a variation of approximately 70-80 kg/h of CO2. The difficulty in operating both with low flow rates and also with higher flow rates where accuracy in the value of the same is requested is thus evident.

[0016] The above is one of the reasons why, for example, in the carbonation of drinks it is preferred to feed the CO2 in the aeriform state, and therefore after vaporisation, a state in which it can easily be regulated, even if

from the point of view of use its feeding in the liquid state would be possible with the consequent advantage of saving due to the lack of costs of vaporisation.

[0017] The second method - as described in US 7,648,569 and US 6,533,252 - provides for the formation of snow and aeriform in a conduit which connects the regulation valve with the use apparatus.

[0018] In this case, in order to avoid blockages, systems are adopted for transferring the snow and the aeriform using the addition of inert gases, or even the same CO2 in the aeriform state obtained from vaporisation of the liquid phase, in order to generate a flow which limits the risk of obstruction of the conduit which, in any case, has to have a very limited length, not over some tens of centimetres, reducing in fact to a stub as extension of the same valve.

[0019] This method has the limits due to the fact that the addition of an inert gas is necessary in order to convey the snow + the aeriform and that in any case the valve for regulation of the flow has to be placed in the immediate vicinity of the use apparatus.

[0020] The third method - as described in U.S. 3,815,377, - overcomes in part the problems of the previous solutions by means of a regulation member, or valve, which replaces the ON-OFF valve used in the first method, an intermediate conduit downstream of the same and the addition of a single-direction valve placed at the end of said conduit and connected to the use apparatus.

[0021] The single-direction valve allows the flow of liquid CO2 to pass in the direction of the valve to the apparatus and is characterised in that it creates a section with variable area for the passage of the flow which opens when between upstream and downstream of this valve, hereinafter referred to for the sake of simplicity as dispenser member, there is a difference in pressure equal to or greater than a defined value and closes again when said pressure difference is smaller than the latter.

[0022] Said single-direction valve operates with functioning similar to that of safety and overflow valves. The pressure difference is obtained by means of the force exerted by a spring.

[0023] For the correct functioning of the method the jump in pressure with which said dispenser member operates has to be such that the pressure upstream of the same - in order not to have the presence of carbonic snow - is greater than that corresponding to the critical point, i.e. 5.1 atm.

[0024] In this case too the CO2 in the intermediate conduit is present in liquid and vapour phase and therefore the regulator valve can operate correctly without the risk of obstructions or clogging in the conduit downstream of the same.

[0025] In brief this third method can be considered a development and improvement of the first where a regulator valve replaces the ON-OFF valve and the dispenser member with variable passage section replaces the calibrated hole or orifice with constant section, replacements which allow operation also with adjustable/variable flow rate.

[0026] The pressure in the intermediate conduit being defined by the force exerted by the spring, it is clear that this solution is suitable for use only when for the performances required it is sufficient for the value of the aforementioned pressure in the intermediate conduit to be constant or, at most, infrequently adjustable, given that for its regulation it is necessary to operate on the spring itself, compressing it or elongating it with manual operations.

[0027] The solution is not suitable instead when a regulation of the flow rate with good precision is required, comprised within a broad range and with frequent variations of the same, aspects which entail - with the pressure constant in the section cited above - extensive variations in the passage section whereto, normally, the constancy of the precision on the values of the flow rate is not associated.

[0028] As an example of the above the fact should be considered that in many applications, such as those indicated previously such as carbonation of drinks and the control of the pH, there is frequently the need to batch the quantity of CO2 in a wide range and always with the same degree of precision so that it is necessary, for the good functioning of the regulation valve, to be able to operate not only on the construction characteristic of the same, (correlated to the passage section) usually indicated as coefficient of flow rate or outflow Kv, but also on the difference in pressure between upstream and downstream of the valve itself, which is not possible, or at least is not easy, to operate with the regulation of the spring.

[0029] DE 4107846 A1 discloses a cylindrical housing with an internal insulating lining having a compression piston which bounds a compression chamber for cryogenic liquid. A LP line leads from a fluid reservoir to the compression chamber and is shut off by an inlet valve. A HP line leaving the compression chamber is opened by an outlet valve. The compression piston works in conjunction with a nitrogen reservoir located on the side farthest from the compression chamber and is activated by a reservoir pressure equal to or greater than the pressure in the compression chamber.

Summary of the invention

[0030] The object of the invention is that of eliminating the disadvantages of the prior art previously illustrated.

[0031] More particularly one object is to allow the formation of the snow and of the aeriform with simple and effective methods, overcoming the conditions posed by current techniques to extend the possibilities of use thereof.

[0032] Another object of the invention is that of making it possible to perform accurate batching also by operating with the liquid phase, which in the conditions of application, that is process temperature and pressure, becomes

snow and subsequently aeriform, so that the use thereof is made possible for the applications previously described without prior vaporisation, with evident financial, energy and environmental impact savings.

[0033] These objects are achieved by the device for the continuous and accurate regulation of a flow of liquid CO2 having the features defined by the independent claim 1, and by the corresponding method defined in the independent claim 16.

[0034] Particular embodiments of the present invention are moreover defined by the dependent claims.

[0035] As is known, the function of a valve regulating the flow rate can be expressed, in its general nature, with the formula

$$(1) \quad Q = Kv \times \sqrt{\Delta P},$$

where Q is the flow rate, Kv is a construction characteristic of the valve correlated to the section used for the passage of the flow, ΔP is the jump in pressure between upstream and downstream of the same.

[0036] The formula highlights the role of the variable ΔP by means of its square root in the regulation of the flow Q.

[0037] In the case of the invention, the pressure upstream being in fact constant and equal to that of the store, the value of ΔP depends, in practice, only on the pressure downstream of the valve, that is on the pressure existing in the intermediate conduit as defined previously.

[0038] In the case of the third method of the state of the art described previously and the formula (1) with ΔP defined by the force exerted by a spring, in practice therefore constant (in the terms seen previously), the pressure upstream of the regulation member being constant, the only variable is obtained in order to regulate the flow rate Q is the construction characteristic Kv of the valve and therefore the variation of its passage section by means of variation of its degree of opening, while being able to operate with different ΔP an extra variable would be obtained to be used, a variable which would confer to the system as a whole much more flexibility and accuracy in the regulation of the flow due to the combinations between values of Kv and ΔP instead of only those of Kv.

[0039] The present invention, as will be described here below, allows operation with this new method, making possible the use of the variable ΔP by means of the replacement of the force exerted by the spring with the force exerted by the pressure of a fluid, here below also indicated as pressurisation fluid, in the aeriform state as particular non-limiting case, and therefore easily adjustable with continuity using known components and techniques.

[0040] By way of an example, as regards the increase in sensitivity on the control of the system as a whole it should be considered that with the use apparatus operating at a pressure around the atmospheric pressure and taking the liquid CO2 from a store at the pressure of approximately 20 bar, the ΔP, in order to have the liquid phase in the intermediate conduit, i.e. between valve and dispenser member, may vary from a minimum of 2 bar (given by 20-18, where the maximum working pressure of the intermediate conduit is assumed equal to 18) and a maximum of 14 bar (value given by 20-6, where 6 is the minimum value of the intermediate conduit below which there is formation of carbonic snow) whose respective square roots are 1.4 and 3.7 and their ratio 3.7/1.4 = 2.6. This means that with valve with constant opening and therefore with the same Kv it is possible to vary the flow rate up to approximately 2.6 times having available for this variation the management of a pressure range of 14-2 = 12 bar. This means that by varying by 0.1 bar the regulation pressure value which can usually be achieved, the corresponding variation of the flow rate is 0.1/12 = 0.008 i.e. 0.8%.

[0041] The above numerical values make clear the sensitivity and accuracy of the regulation of the flow rate which can be achieved with the invention.

[0042] Moreover the invention defines different geometries in order to regulate shape and dimensions of the jet of snow and of the aeriform being dispensed to be used conveniently in different situations as will be explained here below.

[0043] The device which allows the practical application of the invention can operate also at very low temperatures, to approximately -75°C, so that, if necessary, it can be made in material with reduced heat conductivity and/or insulated in an appropriate way.

Brief description of the drawings

[0044] These and other objects, features and advantages of the present invention will be made clearer and more evident by the following description of some preferred embodiments, given by way of an example, with reference to the accompanying drawings, in which:

Fig. 1 illustrates a generic diagram of how the CO2 is currently dispensed applying the third method described previously by means of the use of a spring in order to define the pressure in the intermediate conduit placed between downstream of the regulator valve and upstream of the dispenser member.

Figs. 2, 3 and 4 illustrate 3 different embodiments of the device, or dispenser member, according to the invention, denoted here below, for the sake of simplicity, also by OE/A, OE/B, OE/C, which replace the dispenser member provided with spring as currently used and as shown in Fig. 1,

Fig. 5 illustrates a possible detail of a component of the device according to the invention according to the section A/A of Fig. 2,

Figs. 6A and 6B illustrate two different embodiments of a component of the device according to the invention in order to define the shape of the jet of snow and aeriform in output from the dispenser member.

Figs. 7, 8, 9, 10 and 11 show some modes of application of the dispenser member according to the invention correlated with different possibilities of functioning of the flow rate regulator member,

Fig. 12 illustrates a further variant of the dispenser member according to the invention, hereinafter also denoted by OE/Ar, suitable for being used in particular applications, such as the installation of several dispenser members in parallel controlled by a single regulator valve.

Detailed description of the invention

[0045] In the drawings the identical acronyms and numbers correspond to identical details.

[0046] **In Fig. 1** CA denotes a generic conduit to allow the flow of the liquid CO2 L, to be dispensed, connected, on one side, to a store of CO2 or other conduit (not shown in the drawing), on the other side to a dispenser member OE.

[0047] The conduit CA is provided with a regulation member or valve OR in order to regulate the flow of the liquid CO2 downstream of which, following the losses of load generated by the same member, the CO2 becomes a flow containing liquid + vapour (L+V).

[0048] The dispensing member OE is constituted by a body with a hollow inner part C connected to a conduit U apt to allow the entry of a two-phase flow (S+V) - in output from OE - constituted by the solid, or carbonic snow, + aeriform, in a use apparatus UT.

[0049] A spring M, inside the dispensing member OE, rests with one end on a base wall F of the hollow part C and with the other end on a mobile disk P connected to a threaded rod A, projecting from the base wall F of the hollow body, and on which a nut D is screwed, whose rotation regulates the elongation of the spring M in order to obtain the compression suitable for generating the force required for the functioning of the dispenser member OE.

[0050] The functioning of this working mode as a whole is managed by the regulation member OR which allows the CO2 to flow in the hollow part C and when the pressure in the latter exceeds the one exerted by the spring M on the mobile disk P, the latter moves along the axis X of the hollow part C allowing the flow of CO2 (S+V) to exit U.

[0051] **Figs. 2 and 3** illustrate two different embodiments of the dispensing member according to the invention, denoted respectively by OE/A and OE/B, which replace the dispensing member OE shown in Fig. 1.

[0052] In these drawings 11 denotes a hollow cylindrical body, whose hollow part is denoted by 21, and provided at one end with a flange 13 on which a sleeve 14 is placed, apt to be connected to a conduit, not shown in the drawings, for the feed of the flow of CO2 (L+V). At the other end of the hollow body 11 a disk 16 is provided with passage section 17, on which a gate valve member which, for the sake of simplicity but without detracting from the general nature, is shown as a sphere, 26a for Fig. 2 and 26b for Figure 3, is designed to regulate the breadth of the section 17 used for the passage of the flow of the fluid (L+V) towards the use apparatus UT, not shown in the drawings, operating at a pressure lower than that of the triple point.

[0053] The hollow cylindrical body 11 is provided in its interior with a guide 19 in which a mobile component CM constituted by a piston 22, can slide along its own axis X, restrained at one end of a rod 25, at whose other end the gate valve 26a (or 26b), mentioned previously, is attached.

[0054] The piston 22 - defined by two faces, 23a and 24a for Fig. 2, and 23band 24b for Fig. 3 - can slide inside the guide 19 and during the sliding varies the passage section 17 used for the passage of the flow (L+V).

[0055] The hollow cylindrical body 11 is provided with a sleeve 12 apt to be connected to a conduit, not shown in the drawing, to allow the feeding of a pressurisation fluid G inside the hollow inner part 20-1 of the guide 19, gas which has the task, by means of its pressure, of exerting on the piston 22 the force in order to make it move, in this way providing for functioning of the device according to the invention, replacing in this way the action of the spring in the solution currently known and illustrated in Fig. 1 and described previously.

[0056] The flange 13 and the disk, or base wall, 16 are connected to the cylindrical member 11 with mobile connections in themselves known. In the drawings, by way of an example, the details 15 and 18 respectively are shown as threadings.

[0057] The piston 22 separates the hollow part of the guide 19 in two parts, the part 20-1 apt to receive the fluid G under pressure from the sleeve 12 and the hollow part 20-2 communicating with the hollow part 21 of the cylindrical body 11 and apt to contain the CO2 (L+V) and fed therein by means of the sleeve 14.

[0058] The difference between the embodiments illustrated in Fig. 2 (OE/A) and in Fig. 3 (OE/B) is due to the difference in the relative motion of the mobile component CM - and consequently of the gate valve 26a for Fig. 2 and 26b for Fig. 3 - with respect to the disk 16 in order to increase the section 17 used for the passage of the flow (L+V):

- in the solution of Fig. 2 (OE/A) the component CM moves away from the disk 16, moving backwards towards the interior of the hollow body 11,
- in the solution of Fig. 3 (OE/B) the component CM, or rather the gate valve 26b, moves away from the disk 16, moving forwards towards the exterior of the hollow body 11.

[0059] In both embodiments:

- the fluid G, by means of its pressure Pc, exerts on the piston 22 a force, denoted FC1/a and FC1/b respectively, which operates in the direction of the de-

crease of the section 17 used for the passage of the flow (L+V),

- the flow (L+V), by means of its pressure Pa, exerts on the mobile component CM forces whose resultants are denoted respectively by FA1/a for Fig. 2 (OE/A) and FA1/b and FA2/b for Fig. 3 (OE/B).

[0060] The pressure existing in the use apparatus Pu exerts:

- in the embodiment of Fig. 2 (OE/A) on the gate valve 26a a force FA2/a which operates in the direction of the increase in the section 17 used for the passage of the flow of (L+V)
- in the solution of Fig. 3 (OE/B) on the gate valve 26b a force FC2/b which operates in the direction of the decrease in the section of 17 used for the passage of the flow of (L+V)

[0061] **Fig. 4** shows another embodiment of the dispensing member according to the invention, denoted by OE/C, where the pressurisation fluid G is the same CO2, in the liquid or aeriform state, taken upstream of the regulation member OR.

[0062] In this drawing 40 denotes a hollow cylindrical body constituted by two different hollow cylindrical parts, 40-1 and 40-2, coaxial in the case shown in the drawing, with the latter having the diameter of the hollow part smaller with respect to that of the hollow part of 40-1.

[0063] The hollow cylindrical parts 40-1 and 40-2 are connected one to the other by means of two facing base sections.

[0064] The remaining base of 40-1 is connected - by means of mobile connection 18, shown in the drawing, for the sake of simplicity but without detracting from the general nature of the invention, as a threaded element, similar to what is illustrated in Figs. 1 and 2 - to a base wall 16 provided with passage section 17 for the fluid (L+V) towards the use apparatus.

[0065] Again on the same cylindrical part 40-1 a hole 42 is formed in order to place in communication the hollow part 56-2 with an outside environment whose pressure is denoted by Pe.

[0066] In the remaining base of the cylindrical part 40-2 a sleeve 41 is inserted, apt to be connected to a conduit CA2 for the feeding in the hollow part 55-1 of the pressurisation fluid G (aeriform or liquid CO2) apt to exert the necessary pressure for the correct functioning of the device.

[0067] The conduit CA2 is provided with a system of vaporisation of the CO2, denoted by VP, if it is required for the pressure Pc to be exerted by the aeriform. Contrarily, that is if feeding with liquid CO2 is required, insertion of the vaporisation system VP is not necessary.

[0068] CA denotes the conduit for feeding of liquid CO2 L, with CA1 that of the CO2 (L+V) and OR denotes the regulation valve/member.

[0069] Inside the cylindrical body 40 a mobile component CM is inserted which can slide along its axis and inside the hollow cylindrical parts 40-1 and 40-2 and is constituted by two pistons 51, 52 and by a gate valve 26c, the pistons and the gate valve being connected rigidly one to the other by means of a rod 54.

[0070] The piston 52 separates the hollow part of the cylindrical body 40-1 into two parts, the 56-1 connected to the sleeve 43 and apt to contain the CO2 (L+V) fed via the latter, and the part 56-2 connected to the hole/sleeve 42 which connects the latter to an outside environment.

[0071] The piston 51 separates the hollow part of the cylindrical body 40-2 into two parts: the first, 55-1, connected to the sleeve 41 and apt to contain the pressurisation fluid G which exerts on the piston 51 the pressure Pc, the second part, 55-2, connected to the hollow part 56-2 of the cylindrical body 40-1.

[0072] 51a and 51b and 52a and 52b denote the bases of the two pistons 51 and 52, respectively, whereon the different pressures involved impinge, Pc, Pe and Pa, apt to make the device according to the invention function as described here below.

[0073] The relative position of the two pistons 51 and 52 in the mobile component CM is such that in any position it occupies during the functioning:

- the piston 52 acts as element of separation between the sleeve 43 and the hole 42,
- the piston 51 acts as element of separation between the sleeve 41 and the hole/sleeve 42,
- the hollow parts 55-2 and 56-2 can exchange flows of material with the exterior by means of the hole 42
- the hollow part 56-1 can receive CO2 (L+V) by means of the sleeve 43.

[0074] In order to simplify the subsequent description of the functioning of the invention, in Figs. 2, 3 and 4 the following is indicated:

- **Pc** denotes the pressure of the pressurisation fluid G apt to exert the force (indicated in the drawings by FC1/a, FC1/b and FC1/c) in the direction of decrease of the area used for the passage of the flow (L+V) by means of the movement of the gate valve, respectively 26a, 26b and 26c, with which the section of passage of said flow through the hole 17 in the disk 16 is regulated. Said force is the resultant of the pressure Pc on the surfaces 23a, 23b and 51a respectively for the embodiments of Figs. 2, 3 and 4.
- **Pa** denotes the pressure, exerted by the CO2 by means of the biphase (L+V), apt to exert the force (FA1/a, FA1/b and FA2/c) in the direction of increase of the area used for the passage of the flow (L+V) by means of the movement of the gate valve, respectively 26a, 26b and 26c, with which the section of passage of said flow through the hole 17 in the disk 16 is regulated.

[0075] Similarly to the previous point, said force is the resultant of the pressure Pa exerted on the various surfaces of the components concerned.

- **Pu** denotes the pressure existing in the use apparatus apt to exert a force in the direction of the movement of opening for the case of Fig. 2 (OE/A) and of Fig. 4 (OE/C) and of closure for the case of Fig. 3 (OE/B) of the gate valve, 226a, 26c and 26b with which the section of passage of the CO2 (L+V) through the hole 17 in the disk 16 is regulated.

[0076] In this case too said force is the resultant of the pressure Pu exerted on the various surfaces of the components concerned.

- **Pe,** only in the case of Fig. 4, denotes the pressure existing between the pistons 51 and 52, apt to exert a resultant force (FC2/c-FA1/c) of closure of the gate valve 26c with which the section of passage of the CO2 (L+V) through the hole 17 in the disk 16 is regulated.

[0077] **Fig. 5,** which shows the section A/A of the hollow body 11 of Fig. 2, shows, purely for the purpose of explanation, a possible embodiment of the connection 19a between guide 19 and the cylindrical body 11.

[0078] The same drawing also shows the section 21 apt to allow the passage of the CO2 (L+V) and the circular section of the hollow part 20.

[0079] **Figs. 6A and 6B** show explanatory but non-limiting examples of possible geometric shapes of the gate valve 26b and of their seat (or disk as indicated hitherto) 16a and 16b, shapes apt to dispense the snow + aeriform biphase (S+V) in the use apparatus with two different methods: the first, relating to the solution illustrated in Fig. 6A, in order to have dispensing with shape comparable to a cone, the second, relating to the solution illustrated in Fig. 6B, in order to have dispensing with shape comparable to a disk.

[0080] These different solutions can advantageously be used according to the features of the fluid contained in the use apparatus UT and the needs and restraints of the process which takes place there.

[0081] The solution of Fig. 6b, creating the contact between the snow + aeriform in output from the various dispenser members OE on a surface larger than the case of Fig. 6a is more suitable than the latter in the case wherein it is necessary to avoid high transfers of mechanical energy per unit of fluid contained in the use apparatus and therefore the dispersion of the impact of the flow of (S+V) on a surface, and consequently on a mass, of fluid as broad as possible is necessary.

[0082] The solution 6b is the best because, following the "disk" dispensing (S+V) with the same mechanical energy transferred it does so on a larger surface.

[0083] By way of an example of the above reference is made to the refrigeration of pressed grapes contained in the apparatus UT and to be intended, after refrigeration, for fermentation.

[0084] In this case the excessive mechanical impact concentrated on a reduced mass can generate crushing of the skins with formation of dregs and therefore aggravate the subsequent processes as well as cause a diminishing of the taste and smell qualities of the wine which is produced from this.

[0085] For these aspects the dispensing of the type of Fig. 6b is to be preferred, that is more distributed dispensing of the snow + aeriform.

Mode of functioning of the types (OE/A, OE/B, OE/C) of the dispenser member according to the invention.

[0086] In the following descriptions the forces cited are indicated in two ways FCi/j and FAi/j:

- **FCi/j** denotes a generic closure force, resultant of the pressures as mentioned previously, which acts in the direction of the movement of the gate valve in the direction which involves the decrease, possibly up to closure, of the passage section 17 in respect of the flow (L+V),
- **FAi/j** denotes a generic opening force, resultant of the pressures as mentioned previously, which acts in the direction of the movement of the gate valve in the direction which involves the increase of the passage section 17 in respect of the flow (L+V).

[0087] In the forces indicated the indices **i** and **j** mean:

- **i,** serial index/identification number, of the force
- **j,** type of embodiment (A, B or C, corresponding to OE/A, OE/B and OE/C, respectively shown in Figs. 2, 3 and 4)

  $\sum$**FCi/j** and $\sum$**FAi/j** denote their resultants, respectively of the forces of closure and of opening.

[0088] With the previous definitions, if for each type of OE, that is for the same index j, we have:

- $\sum$**FC**i/j = $\sum$ **FA**i/j the balance is obtained between the forces of closure and of opening which act on the mobile component CM. This means that the closure member 26a (or 26b or 26c) is in equilibrium and immobile with respect to the element 16, therefore the passage for the flow (L+V) is constant, that is closed by the member 26a (or 26b or 26c) or partially or totally open;
- $\sum$**FA**i/j > (greater than) $\sum$**FC**i/j means that the mobile component CM and therefore the closure member 26a, (or 26b or 26c) is not in equilibrium and the forces of opening prevail on said member which will tend to move away from the element 16 increasing, for the flow (L+V), the passage through the section 17 until this moving away modifies the forces involved in such a way as to reach their equilibrium

again.

- $\sum$**FA**i/j > (smaller than) $\sum$**FC**i/j means that the mobile component CM and therefore the closure member 26a, (or 26b or 26c) is not in equilibrium and the forces of closure prevail on said member which will tend to move towards the element 16 decreasing, for the flow (L+V), the passage through the section 17 until this moving closer modifies the forces involved in such a way as to reach their equilibrium again.

[0089] For simplicity of description and in consideration of the approximations possible for the proper functioning of the invention the forces acting on the mobile member CM due to the speed of (L+V) are overlooked.

[0090] The above means that in a certain operating condition of the device of the invention, where the pressure is known of the apparatus (Pu) which has to receive the flow (L+V) and the geometric features of the dispenser member (OE) according to the invention defined, by means of the management of the pressure Pc (pressure of the fluid which exerts the closure forces) it is possible to define the value of the pressure Pa, greater than the pressure of the triple point of the CO2, of the flow (L+V) inside the same device during functioning.

[0091] Control of the pressure Pc in the spaces 20-1 (Figs. 2 and 3) and 55-1 (Fig. 4) is performed with means - such as valves for regulation, interception, pressure reducers, overflow valves, pressure gauges, etc. - and methods in themselves known, not shown in the drawings and not described.

[0092] What is defined and described above allows the dispenser member according to the invention (OE/A, OE/B, OE/C) to operate at the required pressure, greater than the triple point, transferring into the use apparatus all the flow of CO2 (L+V) left to pass by the regulator member/valve (OR), thus achieving the aim of the invention.

Working method between dispenser member according to the invention (OE) and regulation member (OR).

[0093] **Figs. 7, 8, 9, 10, 11 and 12** show, by way of an example, some possible correlations between the functioning of the regulator member OR and the various types of dispenser member (OE/A, OE/B, OE/C) which optimise the performances of the system in its completeness, overcoming the limits present in the systems currently known and cited previously.

[0094] In the drawings cited OL denotes an element, of the PLC type, suitable for controlling the regulation member OR and the valves ORg1 and ORg2, apt to regulate the pressure of the pressurisation fluid G in 20-1 (Figs. 2 and 3) in order to allow the optimal use of the device according to the invention.

[0095] In the following description, for the purpose of illustration, the functioning of the regulation member OR is considered, which can be managed according to the general formula Q= Kv x ΔP as shown previously.

[0096] **Fig. 7** illustrates a mode of manufacture and functioning which provides for the pressure of the fluid G to be constant during functioning. Consequently the regulation member OR operates with a ΔP between upstream and downstream constant if the pressure upstream or the pressure of the end environment in which the CO2 is dispensed remains constant.

[0097] The regulation of the flow is therefore delegated solely to management of the Kv.

[0098] **Fig. 8** illustrates a mode of manufacture and functioning which provides a regulation member OR constituted by a calibrated hole, or orifice FC, comparable therefore to a regulation member with Kv constant, and where regulation of the flow rate during functioning is assigned to the sole variation of the ΔP by means of the management of the valves ORg1 and ORg2.

[0099] **Fig. 9** illustrates a mode of manufacture and functioning which provides a regulation member OR constituted by a valve and therefore with Kv variable, and where regulation of the flow rate during functioning is assigned to both the variation of the ΔP between upstream and downstream of the valve OR by means of the management of the valves ORg1 and ORg2 and to the variation of the Kv of the valve by means of movement of its own gate valve, variations of ΔP and Kv which can take place both singly in time succession and simultaneously.

[0100] With these methods, this solution is characterised by the possibility of operating with high precision in a wide range of flow rates of CO2 as described previously.

[0101] **Fig. 10** illustrates a solution suitable for applications where the distance between regulation member OR and dispensing member OE is such as to allow the flow of (L+V) which forms downstream of OR to form gas bubbles with dimensions such that their traversing of the dispensing member OE can cause pulsations and vibration on the mobile component CM with consequent pulsations on the flow (L+V) in output from the latter.

[0102] To avoid the above the insertion of a component MI is provided with functions of static mixer, a component known to the current state of the art, with the task of dispersing the aeriform phase (V) in the liquid one (L) to make the flow (L+V) sufficiently homogeneous in order to avoid phenomena of pulsations and vibrations as described above.

[0103] The insertion of one or, possible, several components MI may be necessary in particular if, as well as the distance between regulator member (OR) and dispenser member (OE), operation is also performed with high ΔP between upstream and downstream of OR, this is because as ΔP increases the fraction of aeriform produced also increases and with this the lack of homogeneity of the flow (L+V).

[0104] **Figure 11** shows a diagram of embodiment of the invention suitable for distributing the flow (L+V) coming from the regulation member OR by means of several

dispenser members OE, three in the case shown - merely by way of an example - in the drawing and denoted respectively by OE1, OE2, OE3, placed on three different conduits, CA1, CA2, CA3, which depart from a single OR and end in the use apparatus UT.

[0105] In the case wherein flow rates of (L+V) are required, distributed as evenly as possible between single OE, it is necessary to make as similar as possible the losses of load in the various conduits, CA1, CA2 and CA3, between the member OR and the use apparatus UT.

[0106] The above is possible with sufficiently precise method by means of the regulation, for each OR, of the pressure Pc as defined previously, which needs, for each OR, a system of regulation of the relevant value of Pc, or with a different method, also sufficiently precise but simpler and less complex than the previous one and shown in Fig. 12.

[0107] **Fig. 12** shows the version of the device according to the invention, denoted by OE/Ar, which allows the performing of what is described above. It is an addition made to the dispensing member OE/A of Fig. 2 which consists in a spring 61 placed inside the space 20-1 which rests from one end on the surface 23a of the cylinder 22 and from the other on a disk 62 provided with a pin 63 connected by means of threading 64 to the base 65 of the guide 19.

[0108] By means of the rotation of the pin 63 it is possible to vary appropriately the force exerted by the spring on the piston 22, a force which is added to that exerted by the pressure PC, and which allows in this way the balancing of the different load losses (ΔP) of the circuits so that they are sufficiently similar and therefore share in a sufficiently equal way the flow rates among the various OE installed in parallel downstream of a single regulator member OR.

[0109] The features of the spring 61, so that it is suitable for the purpose, have to be such that - as per the law which regulates the force exerted by a spring and which can be expressed with F=KxL, where F is the force exerted by a spring with compressed elasticity coefficient K, with respect to its rest position, and L the length of the spring - as L varies, that is as the position of the mobile member CM varies during the functioning required and therefore of the passage section 17, the force F exerted varies slightly in order to maintain sufficiently constant the losses in the circuit in which it is placed.

[0110] The above performances are achieved by choosing in an appropriate manner the constant of elasticity of the spring 61.

[0111] The same configuration of the invention can be conveniently used when it is required to assign to the force exerted by the spring 61 the definition of the minimum opening pressure - in any case greater than that corresponding to the triple point - leaving to the pressurisation fluid G the possible increases in this.

[0112] The advantage of this solution lies in the fact that also in the absence or malfunctioning of the action assigned to the pressurisation fluid G the device of the invention would retain the capacity to dispense even if not with the care in the precision on the quantity as in the case wherein it also operates with the contribution of the pressurisation fluid G, but which in any case would not cause the formation of snow in the intermediate conduit allowing a use of the device of the invention.

Claims

1. Dispensing device (OE/A; OE/B; OE/C), connected via a conduit (CA) to a store of liquid CO2 for supplying variable flow rates of said liquid CO2 to a use apparatus (UT) operating at a pressure lower than that of its triple point, comprising:

   - a hollow outer body (11; 40) extended along an axis X defining internally at least one hollow part (21; 55-1; 55-2; 56-1; 56-2), provided with a first inlet (14; 43) in order to allow the passage of a flow of CO2 (L+V), coming from said store towards said use apparatus (UT) via an outlet (17), and
   - a mobile component (CM) apt to slide inside said hollow outer body (11; 40) in order to vary the area of the section of passage of the outlet (17) for the flow (L+V) of CO2, wherein on said mobile component (CM) are acting a flow pressure (Pa) of said flow (L+V) of CO2 and a use apparatus pressure (Pu) existing in said use apparatus (UT), as well as a pressure exerting a force contrary to that of the flow pressure (Pa), wherein
   - in said hollow outer body (11; 40) a second inlet (12; 41) is provided for feeding a fluid (G), at a pressurisation fluid pressure (Pc) apt to exert on the mobile component (CM) a force contrary to the force exerted by the flow pressure (Pa),

   characterised in that said mobile component (CM) comprises a rod (25; 54) whereon at least one piston is restrained and carrying, at one of its ends, a gate valve (26a; 26b; 26c) apt to vary the section of passage for the flow (L+V) of CO2 of said outlet (17) formed in a base wall (16) of said hollow body (11; 40).

2. Dispensing device (OE/A; OE/C) according to claim 1, wherein said mobile component (CM) is entirely housed in said hollow body (11;40), and actuates actions of narrowing of the section of passage of the fluid between gate valve (26a; 26c) and outlet (17) by means of a movement along its axis with direction from the inside towards the outside of the hollow body (11;40).

3. Dispensing device (OE/B) according to claim 1,

wherein said gate valve (26B) is placed externally to said hollow body (11;40), and said mobile component (CM) actuates actions of narrowing of the section of passage of the fluid between gate valve and outlet (17) by means of the movement along its axis with direction from the outside towards the inside of the hollow body (11).

4. Dispensing device (OE/A; OE/B) according to claim 1, **characterised in that** on said rod (25) a single piston (22) is mounted, at the end opposite the one carrying said gate valve (26a; 26b), sliding in a guide (19) inside said hollow body (11), wherein said second inlet (12) is provided for feeding said fluid (G), said first inlet (14) being provided in a flange (13), at the end of the hollow body (11) opposite said base wall (16).

5. Dispensing device (OE/A; OE/B) according to claim 4, wherein the fluid (G), apt to exert the pressure Pc, is a generic fluid, in the liquid or aeriform state, more particularly CO2.

6. Dispensing device (OE/C) according to claim 1, wherein said hollow outer body (40) is constituted by two coaxial cylindrical parts (40-1, 40-2) of different diameter, communicating and joined by means of their base, on said rod (54) two pistons (51, 52) being mounted, housed respectively in said coaxial cylindrical parts (40-2, 40-1), and which divide the cavity of the outer body (40) into 4 hollow parts (55-1, 55-2, 56-2, 56-1): the hollow part (55-1), farther from said base wall (16), having said second inlet (41) for the pressurisation fluid (G), the hollow part (56-1) adjacent to said base wall (16) having said first inlet (43) for the CO2 (L+V), and said intermediate hollow parts (55-2, 56-2) being in communication one with the other and with the outside environment via a hole (42), wherein said pressurisation fluid (G) is the same CO2 in the liquid or vapour state.

7. Dispensing device (OE/A; OE/B; OE/C) according to any one of the preceding claims, wherein in said conduit (CA) connected to the store of liquid CO2 a member is provided for regulating the flow rate (OR) of the flow (L+V), and wherein the pressure Pc exerted by the fluid (G) is constant and the regulation of the flow (L+V) is reserved for the regulator member (OR).

8. Dispensing device (OE/A; OE/B) according to any one of claims 1 to 6, wherein in said conduit (CA) connected to the store of liquid CO2 a calibrated hole (FC) is provided and wherein regulation of the flow (L+V) is delegated solely to the pressure Pc of the fluid (G), which can be regulated via valves (ORg1, ORg2).

9. Dispensing device (OE/A; OE/B) according to the preceding claim 1, wherein in said conduit (CA) connected to the store of liquid CO2 a member is provided for regulating the flow rate (OR) of the flow (L+V), and wherein the pressure Pc exerted by the fluid (G) can be regulated by means of valves (ORg1, ORg2) and the regulation of the flow (L+V) is reserved for the regulator member (OR) and the pressure Pc of the fluid (G).

10. Dispensing device (OE/A; OE/B; OE/C) according to one or more of claims 7, 8, 9, wherein an element (OL), such as a PLC, performs the regulation of the flow by acting on the components (OR, ORg1, ORg2) according to a defined logic.

11. Dispensing device (OE/A; OE/B; OE/C) according to any one of claims 1 to 6, wherein in said conduit (CA) connected to the store of liquid CO2 a member is provided for regulating the flow rate (OR) of the flow (L+V), and wherein between the member (OR) and the dispensing device (OE/A; OE/B; OE/C) at least one mixing element (MI) is provided, apt to disperse the CO2 in vapour phase V in the CO2 in liquid phase L.

12. Dispensing system comprising a plurality of devices (OE1,...,OEN) according to any one of the preceding claims, installed in parallel on different conduits (CA1,...,CAN), wherein the flow dispensed by the latter is managed by a single regulator member (OR) placed upstream of said devices.

13. Dispensing system according to claim 12, wherein said devices (OE1,...,OEN) operate with the same pressure Pc of the fluid (G), but are provided with springs (61) apt to regulate the force to be added to that exerted by the pressure Pc in order to generate load losses suitable for regulating the ratios required between the flows dispensed by the single dispenser members (OE1,...,OEN).

14. Dispensing system according to claim 12, wherein the flows dispensed by the single dispenser members (OE) are obtained from appropriate values of the single pressures exerted by the fluid (G) on each dispenser member (OE1,...,OEN).

15. Use of a dispensing device according to any one of claims 1 to 11 where the dispensing of liquid CO2 at the pressure of the store for feeding of the same in apparatuses (UT) containing fluids sensitive to stress, such as musted or pressed grapes, fruit juices and the like, containing solid parts of the same, can damage them, wherein the dispensing device is arranged for dispensing CO2 at lower pressures than the pressure of the store.

16. Method for the dispensing of liquid CO2 in environments at a pressure lower than that of its triple point, using a device according to any one of claims 1 to 11.

Patentansprüche

1. Abgabevorrichtung (OE/A; OE/B; OE/C), die über eine Leitung (CA) mit einem Speicher von flüssigem CO2 verbunden ist, um variable Durchflussraten des flüssigen CO2 an eine Verwendungsvorrichtung (UT) zu liefern, die bei einem Druck arbeitet, der niedriger als dessen Tripelpunkt ist, umfassend:

- einen hohlen Außenkörper (11; 40), der sich entlang einer Achse X erstreckt, die im Inneren mindestens einen hohlen Teil (21; 55-1; 55-2; 56-1; 56-2) definiert, der mit einem ersten Einlass (14; 43) versehen ist, um den Durchgang eines Durchflusses von CO2 (L+V) zu ermöglichen, der von dem Speicher über einen Auslass (17) zur Verwendungsvorrichtung (UT) kommt, und
- eine bewegliche Komponente (CM), die geeignet ist, innerhalb des hohlen Außenkörpers (11; 40) zu gleiten, um die Fläche des Querschnitts des Durchgangs des Auslasses (17) für den Durchfluss (L+V) von CO2 zu variieren, wobei auf die bewegliche Komponente (CM) ein Durchflussdruck (Pa) des Durchflusses (L+V) von CO2 und ein Verwendungsvorrichtungsdruck (Pu), der in der Verwendungsvorrichtung (UT) existiert, sowie ein Druck, der eine Kraft ausübt, die der von Pa entgegengesetzt ist, einwirken,

wobei

- in dem hohlen Außenkörper (11; 40) ein zweiter Einlass (12; 41) zum Zuführen eines Fluids (G) bei einem Druckfluiddruck (Pc) vorgesehen ist, der geeignet ist, auf die bewegliche Komponente (CM) eine Kraft auszuüben, die der durch den Durchflussdruck (Pa) ausgeübten Kraft entgegengesetzt ist,

dadurch gekennzeichnet, dass

die bewegliche Komponente (CM) eine Stange (25; 54) umfasst, auf der mindestens ein Kolben festgehalten wird und die an einem ihrer Enden ein Schieberventil (26a; 26b; 26c) trägt, das geeignet ist, den Querschnitt des Durchgangs für den Durchfluss (L+V) von CO2 des Auslasses (17), der in einer Basiswand (16) des hohlen Körpers (11; 40) ausgebildet ist, zu variieren.

2. Abgabevorrichtung (OE/A; OE/C) nach Anspruch 1, wobei die bewegliche Komponente (CM) vollständig in dem hohlen Körper (11; 40) untergebracht ist und Aktionen der Verengung des Querschnitts des Durchgangs des Fluids zwischen Schieberventil (26a; 26c) und Auslass (17) mittels einer Bewegung entlang ihrer Achse mit einer Richtung von der Innenseite zur Außenseite des hohlen Körpers (11; 40) bewirkt.

3. Abgabevorrichtung (OE/B) nach Anspruch 1, wobei das Schieberventil (26B) außerhalb des hohlen Körpers (11; 40) angeordnet ist und die bewegliche Komponente (CM) Aktionen der Verengung des Querschnitts des Durchgangs des Fluids zwischen Schieberventil und Auslass (17) mittels einer Bewegung entlang ihrer Achse mit einer Richtung von der Außenseite zur Innenseite des hohlen Körpers (11) bewirkt.

4. Abgabevorrichtung (OE/A; OE/B) nach Anspruch 1, **dadurch gekennzeichnet, dass** auf der Stange (25) ein einziger Kolben (22) an dem Ende gegenüber demjenigen, das das Schieberventil (26a; 26b) trägt, montiert ist, der in einer Führung (19) innerhalb des hohlen Körpers (11) gleitet, wobei der zweite Einlass (12) für die Zufuhr des Fluids (G) vorgesehen ist, wobei der erste Einlass (14) in einem Flansch (13) an dem Ende des hohlen Körpers (11) gegenüber der Bodenwand (16) vorgesehen ist.

5. Abgabevorrichtung (OE/A; OE/B) nach Anspruch 4, wobei das Fluid (G), das geeignet ist, den Druck Pc auszuüben, ein allgemeines Fluid in flüssigem oder luftförmigem Zustand, insbesondere CO2, ist.

6. Abgabevorrichtung (OE/C) nach Anspruch 1, wobei der hohle Außenkörper (40) aus zwei koaxialen zylindrischen Teilen (40-1, 40-2) unterschiedlichen Durchmessers, die miteinander in Verbindung stehen und über ihre Basis miteinander verbunden sind, zusammengesetzt ist, wobei auf der Stange (54) zwei Kolben (51, 52) montiert sind, die jeweils in den koaxialen zylindrischen Teilen (40-2, 40-1) untergebracht sind und die den Hohlraum des Außenkörpers (40) in 4 hohle Teile (55-1, 55-2, 56-2, 56-1) teilen: den hohlen Teil (55-1), der weiter von der Basiswand (16) entfernt ist, der den zweiten Einlass (41) für das Druckfluid (G) aufweist, den hohlen Teil (56-1), der an die Basiswand (16) angrenzt, der den ersten Einlass (43) für das CO2 (L+V) aufweist, und die hohlen Zwischenteile (55-2, 56-2), die miteinander und mit der äußeren Umgebung über ein Loch (42) in Verbindung stehen, wobei das Druckfluid (G) das gleiche CO2 im flüssigen oder dampfförmigen Zustand ist.

7. Abgabevorrichtung (OE/A; OE/B; OE/C) nach einem der vorstehenden Ansprüche, wobei in der Leitung (CA), die mit dem Speicher von flüssigem CO2 verbunden ist, ein Element zur Regelung der Durchflussrate (OR) des Durchflusses (L+V) vorgesehen ist, und wobei der vom Fluid (G) ausgeübte Druck

Pc konstant ist und die Regelung des Durchflusses (L+V) dem Reglerelement (OR) vorbehalten ist.

8. Abgabevorrichtung (OE/A; OE/B) nach einem der Ansprüche 1 bis 6, wobei in der Leitung (CA), die mit dem Speicher von flüssigem CO2 verbunden ist, ein kalibriertes Loch (FC) vorgesehen ist, und wobei die Regelung des Durchflusses (L+V) ausschließlich dem Druck Pc des Fluids (G) übertragen wird, der über Ventile (ORgl, ORg2) geregelt werden kann.

9. Abgabevorrichtung (OE/A; OE/B) nach dem vorhergehenden Anspruch 1, wobei in der Leitung (CA), die mit dem Speicher von flüssigem CO2 verbunden ist, ein Element zur Regelung der Durchflussrate (OR) des Durchflusses (L+V) vorgesehen ist, und wobei der vom Fluid (G) ausgeübte Druck Pc mittels Ventilen (ORgl, ORg2) geregelt werden kann und die Regelung des Durchflusses (L+V) dem Reglerelement (OR) und dem Druck Pc des Fluids (G) vorbehalten ist.

10. Abgabevorrichtung (OE/A; OE/B; OE/C) nach einem oder mehreren der Ansprüche 7, 8, 9, wobei ein Element (OL), wie etwa ein PLC, die Regelung des Durchflusses durch Einwirken auf die Komponenten (OR, ORgl, ORg2) nach einer definierten Logik durchführt.

11. Abgabevorrichtung (OE/A; OE/B; OE/C) nach einem der Ansprüche 1 bis 6, wobei in der Leitung (CA), die mit dem Speicher von flüssigem CO2 verbunden ist, ein Element zum Regeln der Durchflussrate (OR) des Durchflusses (L+V) vorgesehen ist, und wobei zwischen dem Element (OR) und der Abgabevorrichtung (OE/A; OE/B; OE/C) mindestens ein Mischelement (MI) vorgesehen ist, das geeignet ist, das CO2 in der Dampfphase V im CO2 in der Flüssigphase L zu dispergieren.

12. Abgabesystem, umfassend eine Vielzahl von Vorrichtungen (OE1,...,OEN) nach einem der vorhergehenden Ansprüche, die parallel auf verschiedenen Leitungen (CA 1,...,CAN) installiert sind, wobei der durch letztere abgegebene Durchfluss durch ein einziges Reglerelement (OR) gesteuert wird, das stromaufwärts der Vorrichtungen angeordnet ist.

13. Abgabesystem nach Anspruch 12, wobei die Vorrichtungen (OE1,...,OEN) mit dem gleichen Druck Pc des Fluids (G) arbeiten, aber mit Federn (61) versehen sind, die geeignet sind, die Kraft zu regeln, die zu der durch den Druck Pc ausgeübten Kraft hinzukommt, um Lastverluste zu erzeugen, die geeignet sind, die erforderlichen Verhältnisse zwischen den von den einzelnen Abgabeelementen (OE1,... ,,OEN) abgegebenen Durchflüssen zu regeln.

14. Abgabesystem nach Anspruch 12, wobei die von den einzelnen Abgabeelementen (OE) abgegebenen Durchflüsse aus geeigneten Werten der einzelnen Drücke erhalten werden, die durch das Fluid (G) auf jedes Abgabeelement (OE1,... ,,OEN) ausgeübt werden.

15. Verwendung einer Abgabevorrichtung nach einem der Ansprüche 1 bis 11, wobei die Abgabe von flüssigem CO2 beim Druck des Speichers zur Zuführung desselben in Vorrichtungen (UT), die auf Belastung empfindliche Fluide enthalten, wie etwa mostige oder gepresste Trauben, Fruchtsäfte und dergleichen, die feste Teile derselben enthalten, diese beschädigen können, wobei die Abgabevorrichtung zur Abgabe von CO2 bei niedrigeren Drücken als dem Druck des Speichers angeordnet ist.

16. Verfahren zur Abgabe von flüssigem CO2 in Umgebungen mit einem Druck, der niedriger als dessen Tripelpunkt ist, unter Verwendung einer Vorrichtung nach einem der Ansprüche 1 bis 11.

Revendications

1. Dispositif de distribution (OE/A ; OE/B ; OE/C) relié par l'intermédiaire d'un conduit (CA) à une réserve de CO2 liquide, pour l'alimentation de débits variables dudit CO2 liquide à un appareil destiné à être utilisé (UT), qui travaille sous une pression inférieure à celle de son point triple, comprenant :

- un corps externe creux (11 ; 40) qui s'étend le long d'un axe X, définissant dans son espace interne au moins une partie creuse (21 ; 55-1 ; 55-2 ; 56-1 ; 56-2) pourvue d'une première entrée (14 ; 43) destinée à permettre le passage d'un écoulement de CO2 (L + V) émanant de ladite réserve en direction dudit appareil destiné à être utilisé (UT) en empruntant une sortie (17); et
- un composant mobile (CM) apte à coulisser à l'intérieur dudit corps externe creux (11 ; 40) dans le but de faire varier l'aire de section du passage de la sortie (17) pour l'écoulement (L + V) de CO2 ; dans lequel, sur ledit composant mobile (CM) agissent une pression d'écoulement (Pa) dudit écoulement (L + V) de CO2 et une pression (Pu) de l'appareil régnant dans ledit appareil destiné à être utilisé (UT), de même qu'une pression exerçant une force contraire à celle de la pression d'écoulement (Pa) ;

dans lequel

- dans ledit corps externe creux (11 ; 40), une deuxième entrée (12 ; 41) est prévue pour l'alimentation d'un fluide (G) sous une pression de fluide de mise sous pression (Pc) apte à exercer,

sur le composant mobile (CM), une force contraire à la force qui s'exerce par l'intermédiaire de la pression d'écoulement (Pa) ;
caractérisé en ce que
ledit composant mobile (CM) comprend une tige (25 ; 54) sur laquelle est maintenu au moins un piston et qui supporte, à une de ses extrémités, un clapet d'obturation (26a ; 26b ; 26c) apte à faire varier la section de passage pour l'écoulement (L + V) de CO2 de ladite sortie (17) pratiquée dans une paroi de base (16) dudit corps creux (11 ; 40).

2. Dispositif de distribution (OE/A ; OE/C) selon la revendication 1, dans lequel ledit composant mobile (CM) est entièrement logé dans ledit corps creux (11 ; 40) et met en œuvre des actions de rétrécissement de la section de passage du fluide entre le clapet d'obturation (26a ; 26c) et la sortie (17) au moyen d'un mouvement le long de son axe dans une direction allant de l'intérieur vers l'extérieur du corps creux (11 ; 40).

3. Dispositif de distribution (OE/B) selon la revendication 1, dans lequel ledit clapet d'obturation (26B) est disposé à l'extérieur dudit corps creux (11 ; 40) et ledit composant mobile (CM) met en œuvre des actions de rétrécissement de la section de passage du fluide entre le clapet d'obturation et la sortie (17) au moyen du mouvement le long de son axe dans une direction allant de l'extérieur vers l'intérieur du corps creux (11).

4. Dispositif de distribution (OE/A ; OE/B) selon la revendication 1, **caractérisé en ce que**, sur ladite tige (25), est monté un piston unique (22), à l'extrémité opposée à celle qui supporte ledit clapet d'obturation (26a ; 26b), qui coulisse dans un guide (19) à l'intérieur dudit corps creux (11) ; dans lequel ladite deuxième entrée (12) est prévue pour l'alimentation dudit fluide (G), ladite première entrée (14) étant prévue dans une bride (13), à l'extrémité du corps creux (11) opposée à ladite paroi de base (16).

5. Dispositif de distribution (OE/A ; OE/B) selon la revendication 4, dans lequel le fluide (G), apte à exercer la pression Pc, est un fluide générique, à l'état de liquide ou aériforme, plus particulièrement du CO2.

6. Dispositif de distribution (OE/C) selon la revendication 1, dans lequel ledit corps externe creux (40) est constitué par deux parties cylindriques coaxiales (40-1, 40-2) de diamètre différent, qui communiquent et qui sont jointes par l'intermédiaire de leur base, deux pistons (51, 52) étant montés sur ladite tige (54), en étant logés respectivement dans lesdites parties cylindriques coaxiales (40-2, 40-1) et qui divisent la cavité du corps externe (40) en quatre parties creuses (55-1, 55-2, 56-2, 56-1) : la partie creuse (55-1), plus éloignée de ladite paroi de base (16), possédant ladite deuxième entrée (41) pour le fluide de mise sous pression (G) ; la partie creuse (56-1), adjacente à ladite paroi de base (16), possédant ladite première entrée (43) pour le CO2 (L + V) ; et lesdites parties creuses intermédiaires (55-2, 56-2) étant mises en communication l'une avec l'autre et avec l'environnement externe par l'intermédiaire d'un orifice (42) ; dans lequel ledit fluide de mise sous pression (G) représente le même CO2 à l'état de liquide ou de vapeur.

7. Dispositif de distribution (OE/A ; OE/B ; OE/C) selon l'une quelconque des revendications précédentes, dans lequel, dans ledit conduit (CA) relié à la réserve de CO2 liquide, on prévoit un élément destiné à la régulation du débit (OR) de l'écoulement (L + V) ; et dans lequel la pression Pc exercée par le fluide (G) est constante et la régulation de l'écoulement (L + V) est réservée à l'élément de régulation (OR).

8. Dispositif de distribution (OE/A ; OE/B) selon l'une quelconque des revendications 1 à 6, dans lequel, dans ledit conduit (CA) relié à la réserve de CO2 liquide, on procure un orifice calibré (FC) ; et dans lequel la régulation de l'écoulement (L + V) est confiée uniquement à la pression Pc du fluide (G) qui peut être régulée par l'intermédiaire de clapets (ORg1, ORg2).

9. Dispositif de distribution (OE/A ; OE/B) selon la revendication 1, dans lequel, dans ledit conduit (CA) relié à la réserve de CO2 liquide, on prévoit un élément destiné à la régulation du débit (OR) de l'écoulement (L + V) ; et dans lequel la pression Pc exercée par le fluide (G) peut être régulée au moyen de clapets (ORg1, ORg2) et la régulation de l'écoulement (L + V) est réservée à l'élément de régulation (OR) et à la pression Pc du fluide (G).

10. Dispositif de distribution (OE/A; OE/B ; OE/C) selon une ou plusieurs des revendications 7, 8, 9, dans lequel un élément (OL), tel qu'un PLC, met en œuvre la régulation de l'écoulement en agissant sur les composants (OR, ORg1, ORg2) conformément à une logique définie.

11. Dispositif de distribution (OE/A ; OE/B ; OE/C) selon l'une quelconque des revendications 1 à 6, dans lequel, dans ledit conduit (CA) relié à la réserve de CO2 liquide, on prévoit un élément destiné à la régulation du débit (OR) de l'écoulement (L + V) ; et dans lequel, entre l'élément (OR) et le dispositif de distribution (OE/A ; OE/B ; OE/C), on prévoit au moins un élément de mélange (MI) apte à disperser le CO2 en face vapeur V dans le CO2 en phase

liquide L.

12. Système de distribution comprenant un certain nombre de dispositifs (OE1, ..., OEN) selon l'une quelconque des revendications précédentes, montés en parallèle sur des conduits différents (CA1, ..., CAN) ; dans lequel l'écoulement distribué par ces derniers est géré par un élément de régulation unique (OR) monté en amont desdits dispositifs.

13. Système de distribution selon la revendication 12, dans lequel lesdits dispositifs (OE1, ..., OEN) travaillent avec la même pression Pc du fluide (G), mais sont munis de ressorts (61) aptes à réguler la force qui doit être ajoutée à celle exercée par la pression Pc dans le but de générer des pertes de charge appropriées pour la régulation des rapports requis entre les écoulements distribués par les éléments de distribution uniques (OE1, ..., OEN).

14. Système de distribution selon la revendication 12, dans lequel les écoulements distribués par les éléments de distribution uniques (OE) sont obtenus à partir de valeurs appropriées des pressions uniques exercées par le fluide (G) sur chaque élément de distribution (OE1, ..., OEN).

15. Utilisation d'un dispositif de distribution selon l'une quelconque des revendications 1 à 11, dans laquelle la distribution de CO2 liquide soumis à la pression de la réserve, pour l'alimentation de ce dernier dans des appareils (UT) contenant des fluides sensibles à des contraintes, tels que du raisin, des jus de fruits et analogues, pressés ou sur lesquels s'exercent des forces, qui contiennent des éléments solides des fruits que l'on vient de mentionner, peut endommager les fluides en question ; dans laquelle le dispositif de distribution est conçu pour la distribution de CO2 soumis à des pressions inférieures à la pression de la réserve.

16. Procédé destiné à la distribution de CO2 liquide dans des environnements dans lesquels règne une pression inférieure à celle de son point triple, en utilisant un dispositif selon l'une quelconque des revendications 1 à 11.

Fig 1

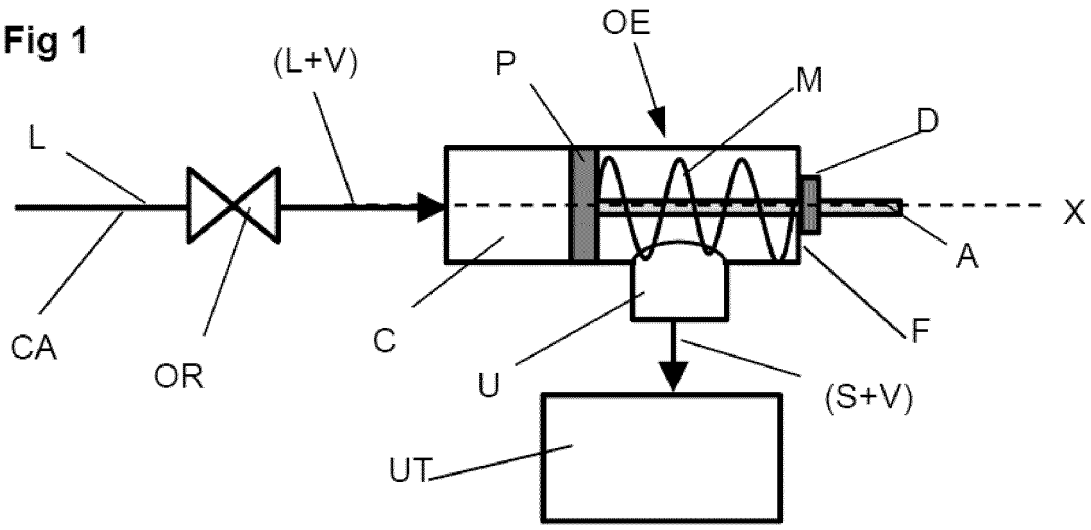


Fig 2

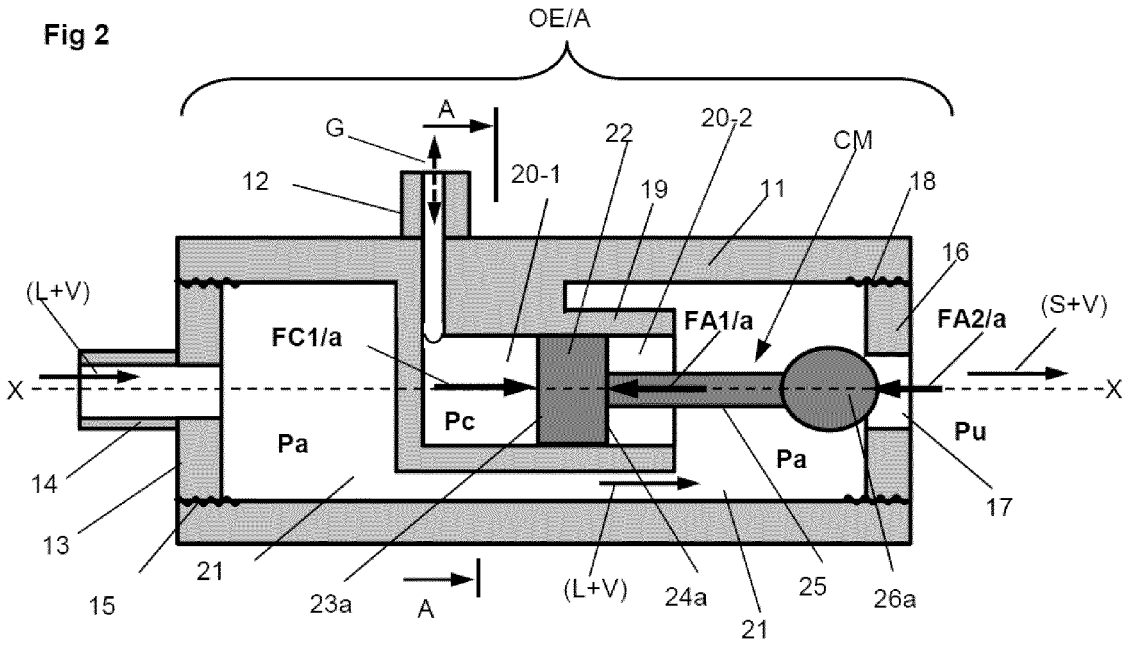
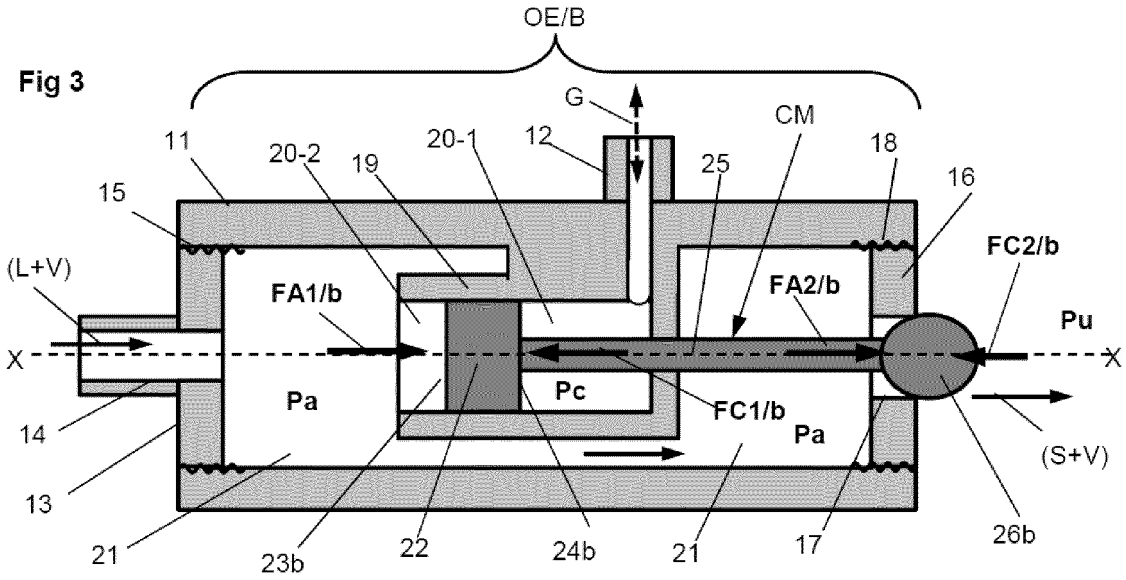

OE/A
A
G
12
20-1
22
20-2
19
11
CM
18
16
(L+V)
FC1/a
FA1/a
FA2/a
(S+V)
X
X
Pc
Pa
Pa
Pu
14
13
15
21
23a
A
(L+V)
24a
21
25
26a
17

Fig 3


OE/B
G
CM
11
20-2
19
20-1
12
25
18
16
15
FC2/b
(L+V)
FA1/b
FA2/b
Pu
X
X
Pa
Pc
FC1/b
Pa
14
13
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21
23b
22
24b
21
17
26b

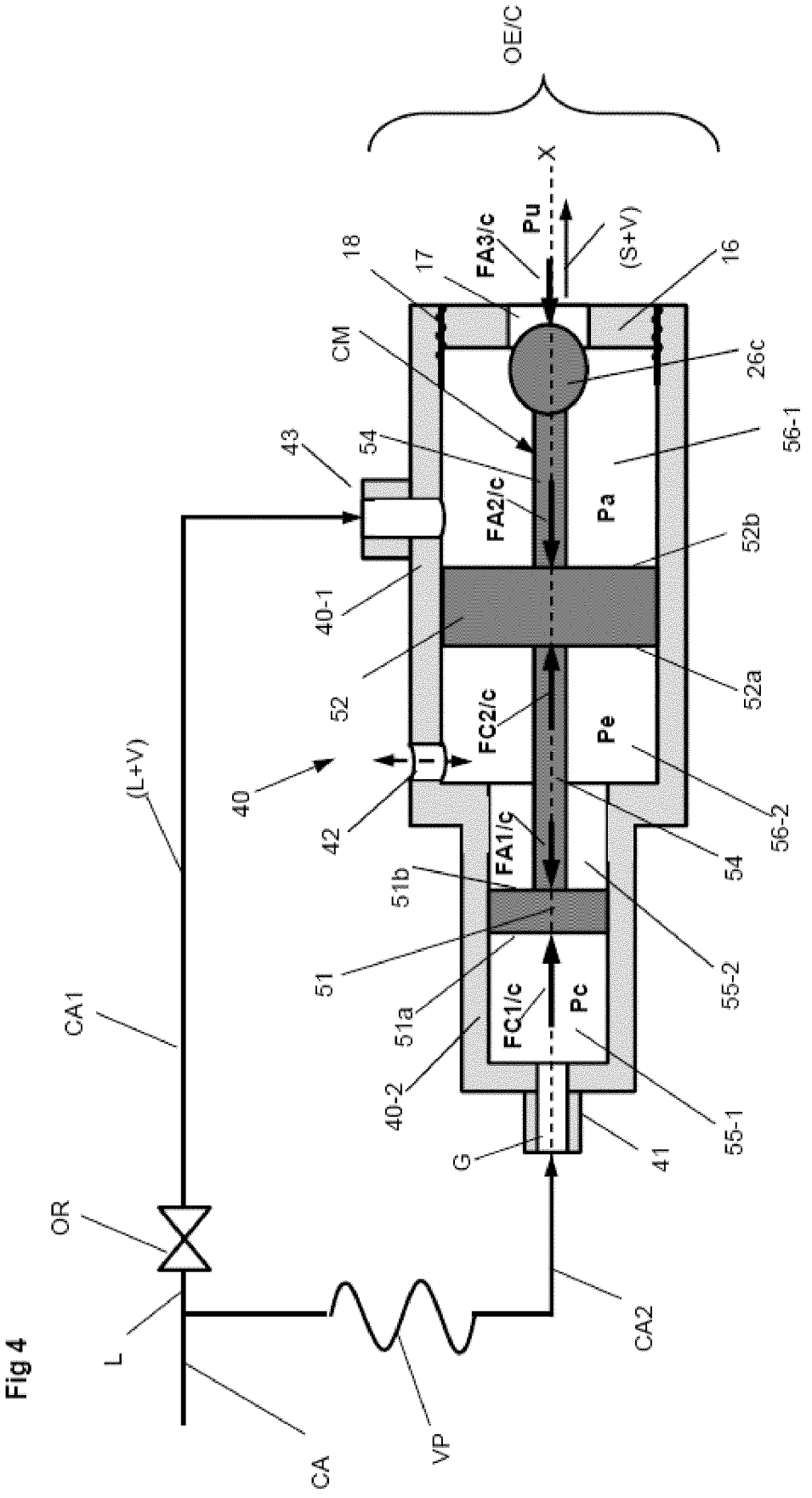

OE/C
X
Pu
FA3/c
(S+V)
18
17
16
CM
26c
56-1
43
54
FA2/c
Pa
52b
40-1
52
52a
FC2/c
Pe
40
42
56-2
54
FA1/c
51b
51
55-2
51a
FC1/c
Pc
40-2
55-1
G
41
(L+V)
CA1
OR
L
CA
VP
CA2

Fig 4

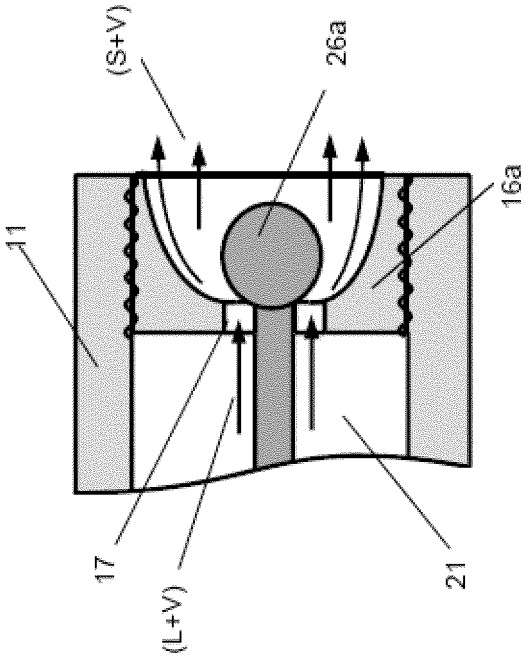


Fig 6 A

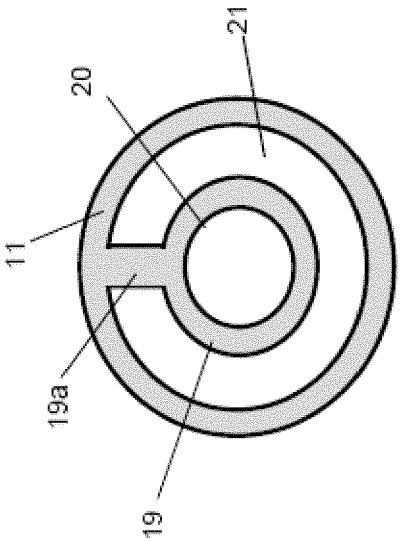


Fig 5

Sez A/A

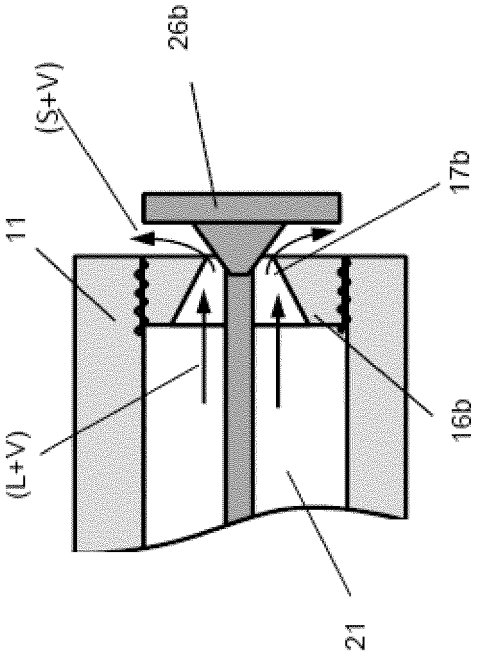


Fig 6 B

Fig 7

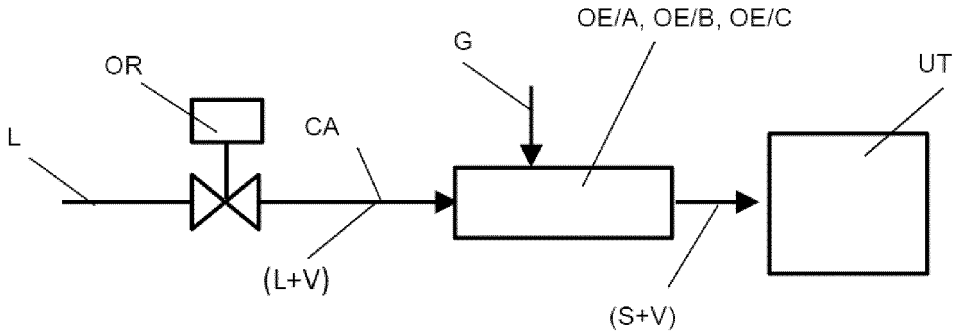


Fig 8

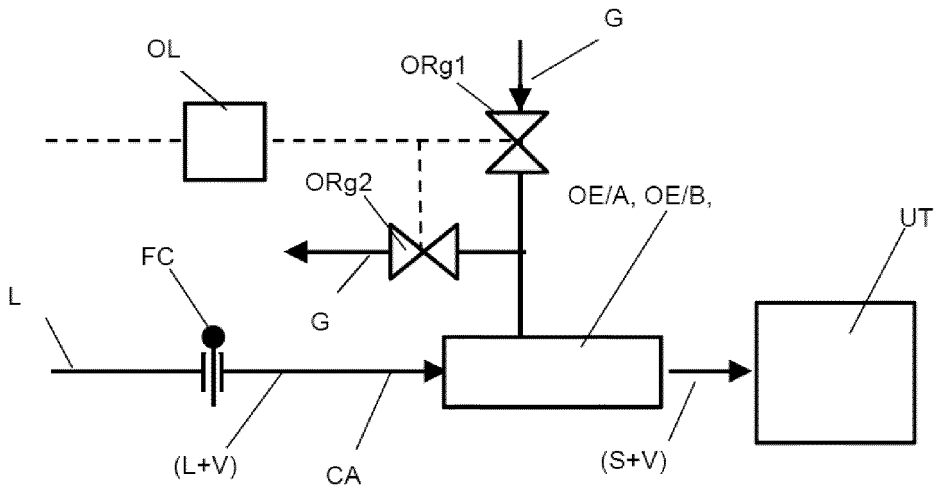


Fig 9

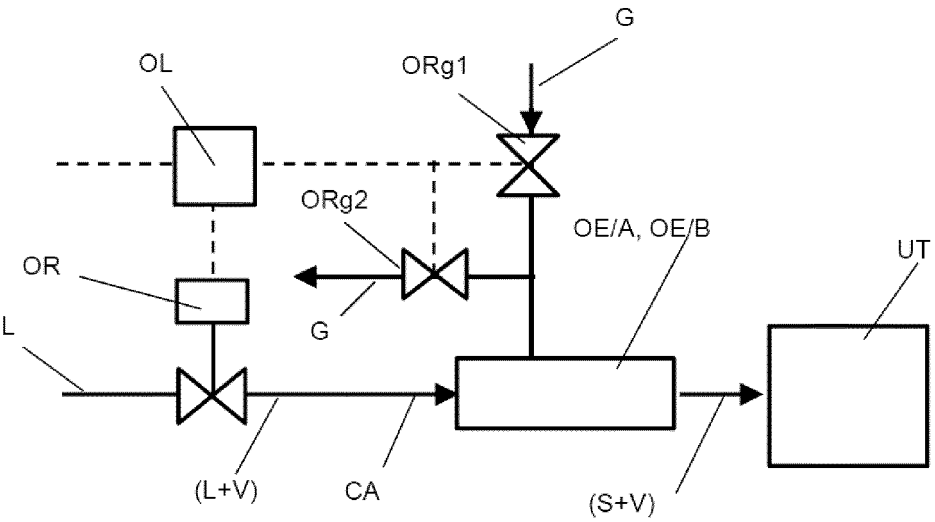


Fig 10

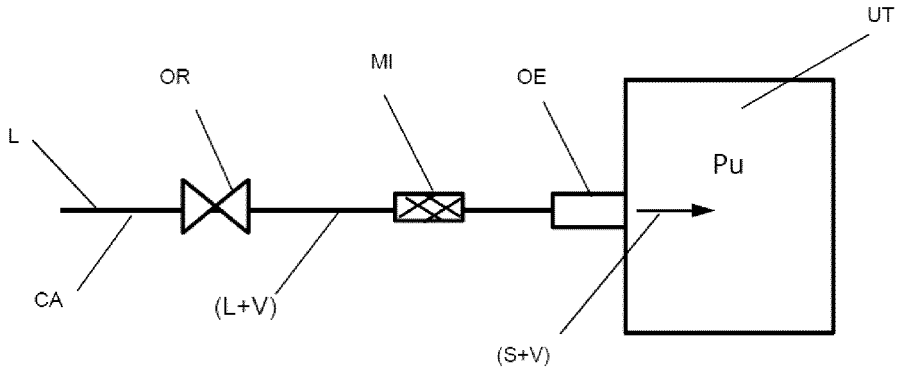


Fig 11

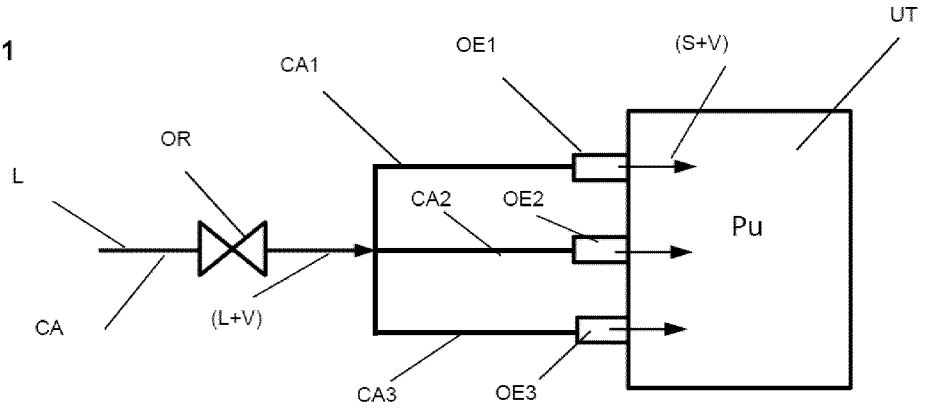
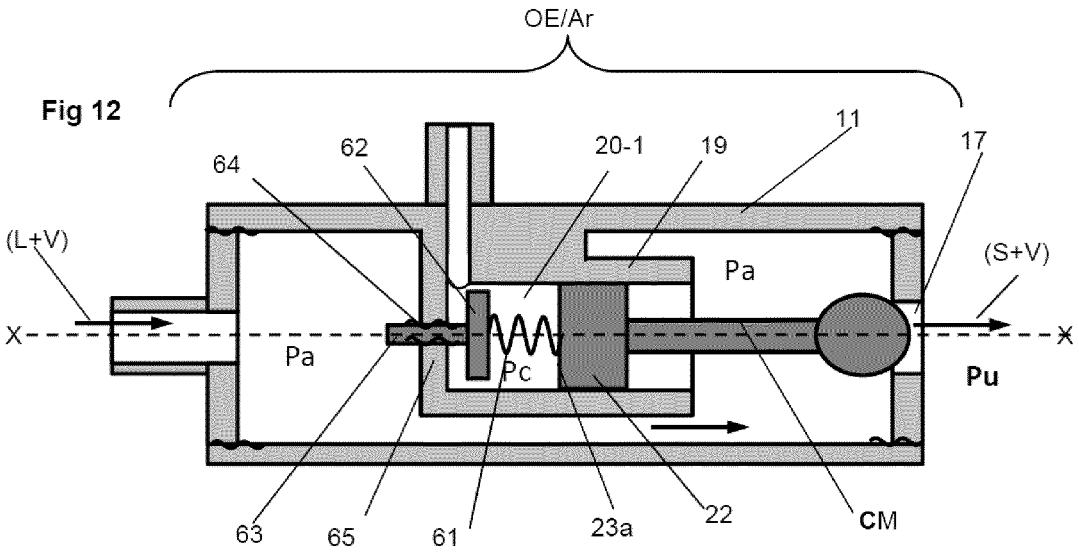


Fig 12



REFERENCES CITED IN THE DESCRIPTION

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